**Ms. No. Sensors-86249-2025** **Authors’ Reply to Reviewers’ Comments**

Analysis and Experimental Validation of SSTDR for Simultaneous Distributed Diagnosis of Wire Networks Sensor Journal.

Change corresponding author to Mouad Addad

Dear Editor and Reviewers,

We would like to thank you very much for your valuable comments and the care and time you took in reviewing this manuscript. We have made substantial revisions to the manuscript, guided by your comments, and believe this has made it a much better paper. Thank you very much. Please find the red-lined manuscript indicating changes made. Also, we have highlighted the changes in response to your comments below.

Thank you again. We appreciate your expertise and comments.

Mouad Addad, Ali Djebbari, Evan Benoit and Cynthia Furse

**Editor’s Comments:**

Based on the enclosed set of reviews this manuscript is not acceptable for publication in its current form, but may be acceptable after being thoroughly reworked. If you choose to resubmit, please send the reworked manuscript as soon as possible. The sooner we receive the resubmission, the better the likelihood that we can utilize the same editor and reviewers.

**Reviewer #1:**

**Reviewer #1 Comment #1:**

Dear Author,

Complex branched cable networks such as the ones found in aircrafts can indeed be installed in harsh environment, which may result in cable defects subsequently leading to critical failure. Reflectometry is therefore a good way to monitor them, and improving old techniques like TDR /distributed TDR is thus always welcome and this makes your motivation really clear.

When I read your paper, it gave me an impression of "déjà vu" and I quickly found out why: you submitted a very similar manuscript (An Enhanced Method for the Distributed Diagnosis of WireNetworks, M. Addad & al..) in 2022.

But your work is now far more complete than it was 2 years ago because you added a whole new experimental validation section, which is greatly appreciated.

**Response to Reviewer #1, Comment #1:** Indeed, this work was submitted for review in 2022. After that, we waited until it was possible to validate the results both experimentally and through simulation. Thank you for agreeing to review this work.

**Reviewer #1 Comment #2:**

I found answers to most of questions I had at the time, except these 3 points which still remain:

- eq. (3): P is missing (upper bound of the sum)

- eq. (7): it should be s'\_{i,m} instead of s\_{i,m}

- eq. (14): it should be \delta\_{l-l\_p} instead of \delta\_{l-p}

**Response to Reviewer #1 Comment #2:** Thank you for pointing this out. These mistakes are corrected in the revised paper.

**Reviewer #1 Comment #3:**

On the downside, I still think you should have cited [1] (I would like to point out I am not one ofthe authors), because it has been available for more than 15 years and already provides answers to most of the issues your method was designed to address.Your main contribution was to replace M/Gold Sequence by ZCZ, but the rest is quite similar.

[1] Distributed Reflectometry-based Diagnosis for Complex Wired Networks, N. Ravot & al.(2007)

Best regards,

**Response to Reviewer #1 Comment #3:** Thank you for pointing this out. The recommended work is now on the list of references.

Thank you for your comments, we believe they have helped improve the paper.

**Reviewer #2:**

Time Domain Reflectometry (SSTDR). By evaluating the pseudo-noise zero correlation zone, it enables simultaneous distributed testing. The work is particularly interesting in the context of simultaneous distributed testing. However, I recommend the following revisions before the paper can be considered for publication:

**Reviewer #2 Comment #1:**

In the abstract, please include performance metrics (e.g., maximum length) to help readers evaluate the work more easily.

**Response to Reviewer #2 Comment #1:** Adding quantitative performance metrics is a very good suggestion. Because of the detail of explaining what the metrics are, we have added them within the text, rather than the abstract. Details are included below:

We have added an SNR performance metric for the code itself to Section III (in the discussion about Fig. 2):

We can define the signal to noise ratio (SNR)) of the code itself as the ratio of the peak of the autocorrelation (A in Fig. 2 which we always normalize to 1) and the peak of the cross correlation B over the zone of interest (Zo). For the ZCZ code shown in Fig. 2, SNR = A/B is infinite. By comparison, *m-* and Gold sequences have SNR = xxx and xxx, respectively [ref].

In Section IV.3.A we also added a metric the translates how the SNR from the codes impacts the actual distributed measurement. We added the following normalized interference error as a second performance metric:

The normalized interference error as shown in Fig. 8 caused by 15 interfering codes can be quantified by averaging the differences between the tests with 0 and 15 interferers across the distance from 0 to 70 m, normalized by the magnitude of the peak at A. For m-sequences, this normalized interference error is xxxx, for Gold, xxxx, and for ZCZ, xxx. Similar results are seen for SSTDR in Fig. 9. With 15 interferers, *m-* and Gold sequences have a normalized interference error of xxx and xxx, respectively, but the ZCZ sequences have only xxx.

**Reviewer #2 Comment #2:**

In Section 2, Equation (6) introduces a cross-correlation function that is used to derive Equation (3) and eliminate noise signals. Please provide a detailed explanation of the reasoning behind this process.

**Response to Reviewer #2 Comment #2:** We suggest two responses: add a correlation term for the noise in equations (6) and (12). And add detail on other ways noise is reduced in SSTDR … baselining & averaging , and how well this does with live signals (eg mil 1553) (Cindy find references).

**Reviewer #2 Comment #3:**

Ensure that all figures include units on the y-axis.

**Response to Reviewer #2 Comment #3:** This is a good point. There are several different ways we could define the magnitudes on the y-axes of these figures. Correlation itself does not have a unit, and neither does reflection coefficient (because it is a ratio of reflected and incident signals). As you have noted, this is important to clarify, however.

We have added the following after (4) when the correlation is first defined:

The magnitude of the correlation in (4) depends on the length of the signals and how well correlated they are, and is called the correlation amplitude we will show in Fig. 2. We will use this correlation, to evaluate more complicated systems, as well.

We have also renormalized Figs. 4-10 to represent reflection rather than correlation. This will allow the user to evaluate the standard reflection coefficient equations when looking at the reflection diagrams. We added this new normalization below Fig. 4 during the discussion of the magnitudes of the peaks:

The magnitude of a reflection at a T-junction between cables of equal impedance is 1/3, so we have used this value to normalize the correlation magnitude, giving the reflection magnitudes (|Reflection|) shown in Fig. 4 and all remaining figures in this paper.

**Reviewer #2 Comment #4:**

The paper employs a test signal amplitude of 62.5 mV. Please discuss whether using different amplitudes would affect the testing results. Additionally, determine whether the test signal is a pulse signal and provide the relevant signal details. If it is a pulse signal, specify its pulse width and explain whether the pulse width impacts the test.

**Response to Reviewer #2 Comment #4:**

**Reviewer #2 Comment #5:**

In Figure 3 (experimental setup), please provide additional details regarding the signal source, sensing component, and demodulation process.

**Response to Reviewer #2 Comment #5:**

**Reviewer #2 Comment #6:**

Include a comparative table that lists and compares the proposed method with other related work.

**Response to Reviewer #2 Comment #6:** Instead of a table, we suggest adding something like the following paragraph as a response to comment 6 from reviewer 2.

“A reflectometry-based measurement technique, such as time domain reflectometry (TDR), uses a step or pulsed incident signal, whereas noise domain reflectometry (NDR) uses existing noise and signals in the system as a passive test system. These techniques are not suitable for testing multiple channels simultaneously, as they would interfere with each other. Testing multiple channels simultaneously requires multiple orthogonal signals. This can be accomplished with spectral time domain reflectometry (STDR) and spread spectrum time domain reflectometry (SSTDR)”.

**Reviewer #3:**

Comments: This paper presents and experimental validation of SSTDR for simultaneous distributed diagnosis of wire networks. However, the serous concerns needs to improve the content of the paper?

**Reviewer #3 Comment #1:**

What is the novelty of the paper? the sate of the art mechanisms are not added and discussed and the number of references is not sufficient

**Response to Reviewer #3 Comment #1:**

**Reviewer #3 Comment #2:**

Please mention the number of equations in the content of paper

**Response to Reviewer #3, Comment #2:** Thank you for this comment. We’ve gone through the paper and completed the equation notation.

**Reviewer #3 Comment #3:**

Why do you choose PN and ZCZ codes? the motivation is not clear in paper.

**Response to Reviewer #3 Comment #3:** Reflectometry-based measurement techniques, such as time domain reflectometry (TDR), use a step or pulsed incident signal. STDR (Sequence Time Domain Reflectometry) uses pseudo noise (PN) sequences as the test signal, and Spread Spectrum Time Domain Time Reflectometry (SSTDR) uses sine or square wave modulated (by PN sequences) test signals. A detailed response to the reviewer's comment is given in Section III as follows :

‘Among the conventional sequences, maximal-length m-sequences have the smallest PACF side lobes. The disadvantage of these sequences is their PCCF peaks which increase rapidly with sequence length. Consequently, m-sequences are optimal for single-point diagnostic systems, but not for simultaneous distributed sensing. Large sets of sequences with relatively good PCCF such as Gold sequences can be generated from a pair of m-sequences called the preferred pair. Zero Correlation Zone (ZCZ) sequences have recently been introduced to the field of wire diagnostics. Their performance was evaluated in the case of simultaneous diagnosis of multiple wires in [7], distributed diagnosis of noisy wire networks in [6], and simultaneous diagnosis of shielded cable bundles in [8]. The distinctive property of ZCZ sequences is that they have a zero-correlation zone in both their PACF and PCCF, where they are ideal for testing. If the zero-correlation zone width is chosen to be large enough to encompass all of the significant reflections in the system, interference from other codes transmitting simultaneously can be eliminated.’

**Reviewer #3 Comment #4:**

The conclusion Section needs to be summarized and the equation shou

**Response to Reviewer #3 Comment #4:**

Thank you again for these very helpful comments. We think they have helped us greatly improve the paper.